

and in Idaho on the 29th. Water-spouts were observed at Key West, Fla., on the 20th, and at Galveston, Tex., on the 30th.

The Arkansas River fell to zero on the gauge at Fort Smith, Ark., on the 12th; this was the lowest stage of water at that place since 1856. The Gila River, Arizona, was high about one-third of the month, and considerable damage was caused by flood. The drought which prevailed in Kansas, Nebraska,

South Dakota, Iowa, northern Texas, Indian Territory, Minnesota, and parts of the upper lake region, and the Ohio valley and Tennessee was generally broken by rain in the early part of the month. Noteworthy auroral displays were reported at Saint Andrews, N. B., on the 14th; at Green Mountain, Me., on the 14-15th, and 18th; at Sault de Ste. Marie, Mich., on the 17-18th, and 19th; and at Saint Vincent, Minn., 19-20th.

### ATMOSPHERIC PRESSURE (expressed in inches and hundredths).

The distribution of mean atmospheric pressure for August, 1890, as determined from observations taken daily at 8 a. m. and 8 p. m. (75th meridian time), is shown on chart II by isobars. The departure of the mean pressure for August, 1890, obtained from observations taken twice daily at the hours named, from that determined from hourly observations, varied at the stations named below, as follows:

Station.	Departure.	Station.	Departure.
Eastport, Me. ....	+ .008	Duluth, Minn. ....	— .005
Boston, Mass. ....	+ .010	Saint Louis, Mo. ....	— .006
New York City. ....	+ .001	New Orleans, La. ....	— .001
Philadelphia, Pa. ....	+ .008	Galveston, Tex. ....	— .010
Washington City. ....	+ .010	Santa Fe, N. Mex. ....	— .012
Savannah, Ga. ....	+ .007	Denver, Colo. ....	— .007
Buffalo, N. Y. ....	+ .007	Fort Assiniboine, Mont. ....	— .008
Detroit, Mich. ....	+ .004	Salt Lake City, Utah. ....	— .013
Cincinnati, Ohio. ....	+ .006	Portland, Oregon. ....	— .012
Chicago, Ill. ....	— .000	San Francisco, Cal. ....	— .016
Saint Paul, Minn. ....	— .003	San Diego, Cal. ....	— .016

The mean pressure was highest from eastern Tenn. to the Atlantic coast between the 30th and 35th parallels, where it was above 30.10, and the mean pressure was lowest over the southwest part of the plateau region, where it was below 29.85. From the middle and lower Mississippi valleys eastward to the Atlantic coast and on the immediate north Pacific coast the mean pressure was above 30.05, and in the British Possessions north of N. Dak. and Mont. the mean readings were below 29.90.

A comparison of the pressure chart for August with that of the preceding month shows that there was an increase in mean pressure, save on the Pacific coast north of the 35th parallel, on the Atlantic coast from southern N. J. to N. S., and over southern Fla. The greatest increase in mean pressure occurred from the upper lake region and the west part of the Ohio Valley westward over the southern and the east parts of the middle and northern plateau regions, where it was more than .05. In sections where there was a decrease in mean pressure the changes were less than .05.

The mean pressure was generally above the normal over the entire country. In the Dakotas, Manitoba, northern Ontario, and at stations in the middle Atlantic states and New England the mean pressure was normal or slightly below. The greatest departures above the normal pressure occurred in the south Atlantic and east Gulf states and thence northward to the southern part of the upper lake region, and in the middle plateau region, where they equalled or exceeded .05.

The monthly barometric ranges at the several Signal Service stations are shown in the table of Signal Service data on the last two pages of the REVIEW.

#### ○ HIGH PRESSURE AREAS.

During the past month the paths of 9 Highs could be traced within the United States for a period of at least 48 hours. 6 of these originated over the Pacific and the other 3 beyond the limits of the map in N. W. T. The paths of these Highs were markedly in high latitudes, only 1, VIII, reaching as far south as 35°, where it lost its identity. The permanent High of the Sargossa Sea seems to have moved slightly west and north of its position in July, and, in consequence, the motion of these Highs tended either to the north or else they gradually spread out and lost their identity as they approached the Atlantic coast. It should be noted that in determining

the velocity of Highs it is often difficult to fix upon the exact starting point, as there frequently seems to be a condition favorable to this formation for several days in one locality before there is any definite movement. There also seems to be a transference of the High from one point to another without a definite motion, this is especially noticeable in the plateau regions. There will be found, at the end of this description, a table which gives the principal points regarding these Highs, and the following details are added:

I.—On the first of the month a High of very slight magnitude was central over Lake Michigan. It was noted on the Pacific coast on July 30th, and seems to have moved or progressed from the Pacific coast at a great velocity. On the succeeding days it was partly merged in the Atlantic High, and all trace was lost on the 2d. One inch of rain fell in the "Col" between this High and another to the south in the 12 hours ending 8 p. m. of the 1st.

II.—Was noted off the Pacific coast p. m. of the 2d. Its path curved south on the 3d, through southern Indiana on the 6th; recurving it passed off the Nova Scotia coast on the 8th. The lowest temperature was 44° at Fort Assiniboine, Mont., a. m. of the 3d, and the highest pressure 30.28 at Rockliffe, Ont., a. m. of 7th.

III.—For several days previous to the 6th the pressure had been rising off the north Pacific coast. The isobars and wind directions a. m. of 7th show this High as an offshoot of the Pacific high just to the northwest of Oregon. This was transferred to Montana during the next 12 hours and remained stationary there till 8th a. m. From this point the course was nearly due east, passing off the Nova Scotia coast a. m. 13th. There was a marked oscillation in the pressure from a. m. to p. m. during its passage, as was noted in many other cases also. The following table gives the area covered by the 30.20 isobar a. m. and p. m. during its progress:

Area of isobar of 30.20.

Date.	Square miles.		Date.	Square miles.	
	A. M.	P. M.		A. M.	P. M.
8 .....	20,000	0	11 .....	300,000	10,000
9 .....	60,000	0	12 .....	400,000	0
10 .....	200,000	0	13 .....	100,000	0

IV.—Originated exactly like III off the Pacific coast, and its path followed the same direction, except that as it approached the Atlantic it had a motion to the southeast, as the permanent High there had apparently moved eastward. In consequence this moved off the coast of Connecticut on 16th. The severe frosts in New York occurred in connection with this High 16th a. m.

V.—Was first noted at Edmonton, N. W. T., 15th. Its motion was rather slow at first, reaching Saint Vincent, Minn., in two days and giving the first frost of the season at that point. It had a motion nearly due east and passed off the Nova Scotia coast 19th a. m.

VI.—Originated off the coast of Oregon a. m. of 17th and it was transferred from there to Montana p. m. of the same day. Its motion had a slight bend to the southward, but its general motion was east. It passed off the Nova Scotia coast on 21st. Rains were quite frequent near the centre.

VII.—Had its origin in Manitoba on 21st. The killing frost at Saint Vincent, Minn., morning of 22d, occurred in its centre; and frosts were reported from lower Michigan the next morning also. The highest pressure of the month (30.40) occurred at Green Bay, Wis., a. m. of 23d.

VIII.—On the evening of the 23d Pacific High had moved to the Oregon coast and an offshoot from this was transferred to Wyoming during the next 24 hours. Its intensity was very slight and it was entirely obliterated in Missouri a. m. of 28th. Quite heavy rain occurred at Denver, Colo., in its centre a. m. of the 26th.

IX.—Was first noted to the north of Edmonton, N. W. T., a. m. of 26th. Its motion was first a little south of east, then east, and it had reached Lake Erie on the last day of the month.

#### LOW PRESSURE AREAS OR STORMS.

There were 11 Lows having a motion for at least 2 days during the past month. Seven of these were first noted in N. W. T. The general path was to the north, exactly as in July. The principal characteristics are given in a table at the end of this description. The following notes are added:

I.—Had an origin in Wyoming on the last day of July; its motion was a little north of east and was last noted on the 2d to the north of Lake Superior, though its effects were felt along the upper lakes a few days later. The heaviest rain in 12 hours, 2.40, was at Dubuque, Iowa, a. m. of 3d.

II.—Was first noted in N. W. T. on 5th; its motion was nearly due east, and it passed off Anticosti 11th. The heaviest rain in 12 hours was at Narragansett Pier, R. I., 2.05, 9th.

III.—Like the last was noted in N. W. T. on the 9th. Its progress was rather erratic but generally east, and it passed down to the mouth of the Saint Lawrence on 15th. The heaviest rain in 12 hours, 1.04, was at Washington City, 15th.

IV.—Was like the last in its origin, on the 13th, and in its path; it disappeared off Nova Scotia 18th; a remarkable rain of 3.20 in 70 minutes is reported at Colorado Springs p. m. of 14th. This point was more than 900 miles from the storm-centre, but the rain seems to have been connected with it.

V.—This storm originated in S. Dak. on the 15th; its motion was due south, and all trace of it is lost on 17th. It may be regarded as an offshoot from IV. Rain to the amount of 2.00 in 12 hours was reported at Fort Smith, Ark., on 17th.

VI.—In most respects this was the most remarkable storm of the month. Starting in the Panhandle of Texas a. m. of the 18th, it had a motion of 45 miles per hour, a little east of north. This was the highest velocity of any storm during the month. As shown by the isobars it had a very slight intensity, the pressure scarcely falling below 30.00 during the whole course. It also had the lowest velocity of the wind accompanying it, with one exception. A rainfall of 1.17 in 12 hours was reported from Parkersburgh, W. Va., 20th. But the most memorable event in its course was the Wilkes Barre, Pa., tornado on the 19th. In this 16 persons lost their lives, and nearly \$600,000 of property was destroyed. (See "Local storms.")

VII.—Started in Manitoba on the 19th and moved nearly due east to the mouth of the Saint Lawrence on the 25th. The last three days of its motion the path was very erratic. The most widespread general rain of the month accompanied this storm, 1.60 in 12 hours being reported at Toledo, Ohio, on the 21st.

VIII.—This storm started in the N. W. T. on the 21st. Its motion was nearly due east and it passed off the Nova Scotia coast on the 28th. The highest wind velocity of the month, but one, 58 miles per hour, was reported with this storm on the 24th at Valentine, Nebr. A rainfall of 2.54 in 12 hours was reported from Cincinnati, Ohio, on the 26th.

IX.—Similar to VI, this storm originated in the Panhandle of Texas on the 25th. Its motion was first se. till the 27th, on which date the cyclone in the Gulf, notice of which is given later in "North Atlantic storms," united with it. After the 27th its course was nearly due east, its last appearance being on the Carolina coast on the 29th. This storm undoubtedly

united with the West India cyclone which approached the Atlantic coast on the 30th from the se.

The heavy rainfall in connection with this storm was quite interesting. For 12 hours ending p. m. of the 25th 1.06 fell at Concordia, Kans., which was on the north border about 400 miles from centre. In the next 12 hours 1.80 fell at Fort Sill, Ind. T., and 1.08 at Fort Elliott, Tex., in the centre, nearly. In the next period of 12 hours 0.52 fell at Port Eads, La., about 300 miles to se. of centre. In the next period 1.17 fell at New Orleans, about 300 miles in front, 1.48 at Memphis, Tenn., about 450 miles to the ne., and 1.00 fell at Nashville, 600 miles ne.; while there was not a drop at Meridian, Miss.; 250 miles ene.; 0.04 at Mobile, Ala., nearly e. of centre, and 0.02 at Port Eads, La., 200 miles ese. of centre. In the next period 1.32 fell at Vicksburg, Miss., 100 miles in front, and 1.00 at Meridian, Miss., about 200 miles in front or e. of centre. None fell at Pensacola, Fla., 300 miles ese. of centre. In the next period 1.02 fell at Mobile, Ala., 200 miles s., and 1.08 at Montgomery, Ala., about 200 miles e. In the next period 1.34 fell at Chattanooga, Tenn., 1.50 miles n., and 1.01 at Pensacola, Fla., the same distance s. In the next 12 hours ending a. m. of the 29th 1.42 fell at Charlotte, N. C.; about 100 miles n., while none fell at Charleston, very near the centre. As the storm passed off the coast 3.16 fell from 8 a. m. to 3.20 p. m. on the 29th at Hatteras, N. C., about 200 miles to n. of centre. During 29th 3.10 fell at Lumberton, N. C., 3.00 at Athens, Ga., 2.40 at Cheraw, S. C., and 2.30 at Columbia, S. C., which was the heaviest rain of the month at so many stations.

X.—Originated in Manitoba on the 26th. Its course was slightly se. at first, then gently bending to ne. it passed off the Nova Scotia coast on 31st. The rainfall during its whole course was insignificant, the heaviest in 12 hours, 0.63, occurring at Manchester, N. H., on 30th.

The following table gives the approximate velocity of Highs and Lows during July and August. In this table the middle day of the storm instead of the first day is taken as the proper point in chronological order:

		July.															
Number	.....	I L	I L	I H	I L	I H	I L	I H	I L	I H	I L	I H	I L	I H	I L	I H	I L
Velocity	...	11	13	22	29	24	20	14	29	42	19	17	16	18	35		

  

		August.															
Number	.....	I H	I L	I H	I L	I H	I L	I H	I L	I H	I L	I H	I L	I H	I L	I H	I L
Velocity	.....	37	23	29	20	19	21	22	23	26	30	45	41				

These velocities have a maximum on July 16th, August 1st, and August 19th. A study has been made of storm velocities for the past 20 months, but it has been found impossible to make a satisfactory determination of the velocity. If there is a regular progression in our storms and Highs it should be possible to determine it day by day.

The velocities of either High or Low for any day in any part of the country were combined together to form a mean velocity of progression in the upper current, or in whatever action may be supposed to cause these motions. The following table exhibits these mean velocities for August:

Date	July 30 a. m.	31 p. m.	Aug. 1	2	3	4	5	6	7
Velocity	63	49	25	21	18	35	31	32	37
Date	8	9	10	11	12	13	14	15	16
Velocity	30	31	12	15	17	18	15	11	7
Date	20	21	22	23	24	25	26	27	28
Velocity	43	35	40	40	19	27	11	11	14

In this table the date has two figures under it; the first is the motion from 8 p. m. of previous day to 8 a. m. of this date, and the second the motion from 8 a. m. to 8 p. m. of this date. It will be seen by these figures that there is a maximum in this progression on July 30th and on August 19th, with secondary maxima on August 4th and 8th, and a very quiet period from August 23d-31st. The uniformity of velocity in this table is quite remarkable considering the fact that it is taken from all parts of the country and in both Highs and Lows. There is only a single serious break and that is on the 18th.

As noted in the July REVIEW there seems to be an increase of velocity as the Low passes along the higher latitudes and

also there is often a long delay in the beginning of a storm or High, so that great care is needed in measuring the velocity.

The following table gives the approximate velocity of storms during the past 18 years. There has been no opportunity to make a projection of the tracks or measurement of these velocities except such as a close scrutiny of records would give:

Year.	Number.	Velocity per hour.	Year.	Number.	Velocity per hour.
		Miles.			Miles.
1873	6	28.0	1883	6	25.0
1874	7	24.0	1884	5	32.0
1875	4	17.0	1885	6	23.0
1876	6	21.0	1886	6	32.0
1877	5	22.0	1887	5	27.0
1878	4	25.0	1888	6	23.0
1879	6	22.0	1889	6	24.0
1880	4	32.0	1890	10	24.0
1881	4	28.0			
1882	5	23.0	Mean	5.6	25.3

\* Little significance can be placed upon the marked diminution in 1875 nor on the increase in '80, '84, and '86. It is probable that the mean velocity of storms during July in this country is about 24 miles per hour, and in August perhaps a very little greater. During the earlier years it was very difficult to trace storms to the west of the Mississippi and, as it is probable that the velocity is a very little less in that region than to the east, we may consider these values as slightly in excess, if anything.

As already noted under High III, there is a uniform oscillation in air pressure from morning till night. In order to find whether this extended to the Low as well, the following table was prepared showing the area in square miles within the isobar 30.20 and also within the isobar 29.60. A serious difficulty exists in such measurements owing to the lack of ob-

servations to the north. The observations at high stations in British N. W. T. cannot be used since the observed temperature is used for reducing barometer readings to sea level, while in the United States this difficulty is overcome by using the mean 24-hour temperature for making the reduction, thus eliminating the diurnal range of temperature from 8 a. m. to 8 p. m.:

Table showing mean area (in square miles) of isobars 30.20 and 29.60.

Date.	30.20.		29.60.		Date.	30.20.		29.60.	
	A. M.	P. M.	A. M.	P. M.		A. M.	P. M.	A. M.	P. M.
1	0	0	30,000	240,000	17	1,100,000	500,000	0	0
2	30,000	0	20,000	20,000	18	900,000	250,000	0	0
3	40,000	0	0	0	19	700,000	150,000	0	0
4	0	0	0	20,000	20	5,000	0	0	0
5	0	0	0	20,000	21	100,000	50,000	0	20,000
6	300,000	0	0	80,000	22	800,000	400,000	1,000	20,000
7	120,000	2,000	0	20,000	23	650,000	400,000	0	40,000
8	20,000	0	0	0	24	600,000	10,000	10,000	40,000
9	60,000	0	0	0	25	10,000	0	5,000	0
10	200,000	0	0	40,000	26	0	0	0	0
11	300,000	10,000	0	0	27	0	0	50,000	200,000
12	400,000	0	0	0	28	0	0	100,000	100,000
13	150,000	0	0	0	29	0	0	0	80,000
14	90,000	0	0	80,000	30	0	0	0	150,000
15	150,000	50,000	0	0	31	200,000	100,000	100,000	0
16	800,000	200,000	0	0					

This table shows that there is a marked oscillation in the centre of a High, the pressure being very much higher in the a. m. than p. m. In the centre of Low there is also an oscillation in the opposite direction, but the isobar of 29.60 is a little too low to show this well in August. With a few exceptions the pressure is lower in a Low in the p. m. than in the morning. This would seem to have an important bearing upon the question of the diurnal range of the barometer, and, when properly studied, may possibly assist in developing the theory of storms.

Tabulated statement showing principal characteristics of areas of high and low pressure.

Barometer.	First observed.			Last observed.		Duration.	Velocity per hour.	Maximum pressure change and maximum abnormal temperature change in twelve hours and maximum wind velocity.											
	Date.	Lat. N.	Long. W.	Lat. N.	Long. W.			Station.	Rise.	Date.	Station.	Fall.	Date.	Station.	Direction.	Miles per hour.	Date.		
High areas.		°	°	°	°	Days.	Miles.		Inch.			°							
I.	1	44	88	43	68	3.5	37	Father Point, Quebec.....	.26	1	Philadelphia, Pa.....	19	1	Sandusky, Ohio.....	ne.	16	1		
II.	2	47	125	47	60	5.5	29	Bismarck, N. Dak.....	.32	2	Fort Sully, S. Dak.....	19	2	Helona, Mont.....	nw.	20	2		
III.	6	47	126	47	62	7.0	19	Anticosti Island, G. St. L.	.35	12	Bismarck, N. Dak.....	21	7	Chicago, Ill.....	ne.	40	11		
IV.	11	46	124	41	72	5.5	22	Saugeen, Ont.....	.35	15	Swift Current, N. W. T.....	21	11	Block Island, R. I.....	ne.	14	16		
V.	15	53	116	46	59	4.0	30	Huron, S. Dak.....	.44	16	Fort Assiniboine, Mont.	27	15	.....do.....	e.	24	19		
VI.	17	48	126	45	61	3.5	41	Chatham, N. B.....	.30	20	Dodge City, Kans.....	21	19	.....do.....	e.	18	21		
VII.	21	52	105	42	79	3.5	18	Father Point, Quebec.....	.34	22	Bismarck, N. Dak.....	25	21	Grand Haven, Mich.....	nw.	30	22		
VIII.	23	48	125	38	82	4.5	19	Eastport, Me.....	.30	28	Concordia, Kans.....	15	25	Fort Assiniboine, Mont.	sw.	14	26		
IX.	26	54	115	42	82	5.0	17	Rockliffe, Ont.....	.26	30	Huron, S. Dak.....	16	29	Chicago, Ill.....	e.	12	30		
Mean.....						4.7	26		.32			20				21			
Low areas.									Fall.			Rise.							
I.	1	46	104	49	90	2.0	23	Huron, S. Dak.....	.34	1	Valentine, Nebr.....	18	1	Marquette, Mich.....	sw.	48	2		
II.	5	51	110	50	62	5.5	20	Halifax, N. S.....	.24	10	Rapid City, S. Dak.....	24	6	Fort Sully, S. Dak.....	nw.	56	7		
III.	9	52	115	51	63	5.5	21	Fort Sully, S. Dak.....	.24	11	Fort Sully, S. Dak.....	15	9	Rapid City, S. Dak.....	sw.	56	11		
IV.	13	51	116	47	62	4.5	23	Fort Buford, N. Dak.....	.36	14	Northfield, Vt.....	19	17	Fort Sully, S. Dak.....	nw.	44	15		
V.	15	45	98	34	94	2.0	26	Fort Smith, Ark.....	.14	16	Cairo, Ill.....	10	16	Kansas City, Mo.....	nw.	26	16		
VI.	18	36	102	48	63	2.0	45	Chatham, N. B.....	.34	20	Sydney, C. B. I.....	10	20	Eastport, Me.....	se.	28	20		
VII.	19	52	105	51	66	5.5	25	Montreal, Quebec.....	.48	21	Fort Buford, N. Dak.....	21	19	Montreal, Quebec.....	s.	44	22		
VIII.	21	53	116	47	60	7.0	18	Eastport, Me.....	.62	27	Fort Custer, Mont.....	20	21	Valentine, Nebr.....	n.	68	24		
IX.	25	36	102	35	73	5.0	19	Wilmington, N. C.....	.18	29	Mobile, Ala.....	10	27	Port Eads, La.....	sw.	48	27		
X.	26	51	104	46	62	4.5	18	Milwaukee, Wis.....	.24	28	Cheyenne, Wyo.....	26	26	Buffalo, N. Y.....	sw.	32	29		
Mean.....						4.4	24		.32			17				45			

## NORTH ATLANTIC STORMS FOR AUGUST, 1890 (pressure in inches and millimetres; wind-force by Beaufort scale).

The paths of the storms that appeared over the north Atlantic Ocean during August, 1890, are shown on chart I. These paths have been determined from international observations by captains of ocean steamships and sailing vessels received through the co-operation of the Hydrographic Office, Navy Department, and the "New York Herald Weather Service."

Eight storms have been traced for August, 1890, the average number for the corresponding month of the last 7 years being

9. Of the storms traced for the current month 4 were continuations of storms which first appeared over the North American continent; one was central on the 1st north of Newfoundland; one moved eastward between the Grand Banks and Greenland, thence southeastward to about the 20th meridian, and thence northward to the British Isles; one apparently developed off the middle Atlantic coast; and one is given an approximate north of west path north of the West Indies to a